MASTER CY

CELRH-EC-D

28 December 1999

MEMORANDUM FOR RECORD

SUBJECT: ORMSS General Lock Model Meeting of 9 -10 Nov 99

1. The Ad-Hoc Group, formed under the auspices of the Regional Navigation Design Team, met in Vicksburg, MS at the Waterways Experiment Station (WES) to continue discussions on the Lock Model Facility for Filing and Emptying Systems as it relates to the Ohio River Mainstem System Study (ORMSS). Those in attendance are listed below:

NAME	ORGANIZATION	TELEPHONE/FAX NO.
John Hite	CEERD-HN-N	601-634-2402
Jose E. Sanchez	CEERD-HN-N	601-634-3895
David Schaaf	CELRL-ED-DS	502-582-6967/5108
Byron McClellan	CELRL-ED-D	502-582-5691
Brian Houston	CELRL-ED-DS	502-582-6009
Coy Miller	CELRH-EC-WH	304-529-5601/5960
Jason Merritt	CELRH-EC-DS	304-529-5741/5209
Billy Arthur	CELMS-ED-HE	314-331-8333
Tom Quigley	CELMS-ED-DA	314-331-8220
Michael Fallon	CELRH-EC-D	304-529-5202/5209

2. The meeting began at 1300 hrs with introductions from attendees. The agenda generally covered the following topics/points: Update from WES on Model Status; Discussion and Finalizing of Details for WES; Construction and Testing Schedule; Funding Status; Site Visit to Model or to fabrication shop (time permitting).

3. The milestones identified in the schedule provided by WES in Oct 99 are still on track for completion. Facility design and construction are well underway and due for completion in mid-December. Design and construction for the actual Lock Model was just getting underway at the beginning of Nov 99 and is scheduled for completion by the end of Mar 99. Phase I testing is scheduled to begin on/about 1 Apr 99.

4. Discussion then focused on the many details to be resolved e.g. various culvert sizes to be considered for modeling, minimum draft vs. minimum pool, whether or not emergency sills should be included in model design, and culvert transitions into and out of lock walls. It was generally agreed that the most severe of physical constraints should govern. If the test results were favorable at Greenup Locks then similar parameters applied to J.T. Myers Locks should also provide favorable results. Messrs. Schaaf and Houston provided a handout/discussion on the ORMSS Physical F/E Model - Testing Computations Culvert Design (**Enclosure 1**). The computations provided a scenario for the new supplemental culvert size along with the proposed location. The computation package also included proposed configurations for the filling and emptying culvert systems.

5. Mr. Schaaf then provided a handout for discussion regarding the costs associated with the triple culvert through the sill system (General Model) vs. the wrap around culvert option (**Enclosure 2**). The cost estimate that was developed was for a through-the-sill supplemental culvert system specific to the quantities at Markland, which is very similar to Greenup. However, the culvert design was determined using properties at Greenup. Costs were considerably higher for the wrap around system (approximately three times). Reviewing the cost estimates at both sites (Myers and Greenup) easily shows that going with the through-the-sill option generates savings. The largest savings are generated by less extensive site preparation, no excavation/shoring required, no drilled shaft wing wall, relocation of fleet mooring facility not required, etc.

6. Messrs. Schaaf and Houston then presented plan sheets of the proposed General Lock Model, which will serve as the guide plans for WES's construction effort (**Enclosure 3**). Detailed discussions followed regarding the configuration of the culverts as they transition back into the walls, the location of the new auxiliary lateral field, and the pintle to pintle distance. It was also determined that the title of these of drawings should read, "ORMSS General Lock Model - Filling and Emptying System".

7. The final actions/decisions were reviewed and noted before closing the meeting:

a. LRH will conduct numerical modeling in order to perform a sensitivity analysis of the F/E system by varying the culvert size (cross-section) for Myers and Greenup. This action has been completed and the results of this numerical analysis can be found in the CELRH-EC-WH memorandum, dated 26 Nov 99, subject: Ohio River Mainstem Study Numerical Model Investigations (**Enclosure 4**). This investigation revealed that the potential exists for reductions in fill times due to implementing supplemental F/E features.

b. WES will conduct innovative research with flume tests to analyze the effects of locating the laterals over the existing ports in the 600' lock and place a block at the 800' point to simulate the extension. Initial thoughts are to place new culvert 12.5' away from chamber walls (Greenup will be the control design in this case).

c. WES will conduct navigational tests with respect to draft when the new flume is operational.

d. WES will site adapt data from results determined in 7.a. and 7.b. for the model construction. The number of laterals, positions, sizes, w/without emergency sill, pintle to pintle distance, and minimum submergence are all physical characteristics to be optimized by the WES modeling effort. For consistency, top of upper miter gate will be designated at 100'm.s.l. and the station of the upper pintle centerline will be 0+00.

e. There will be no butterfly valves, reverse tainter valves in walls. Distance of valves to the new lateral field is critical.

f. LRL and LRH to provide WES with working sketches of possible culvert transitions.

g. LRH to provide LRL with half-size drawings of Meldahl and Greenup Locks.

h. All attendees agreed that the Lock Model Scope of Work, dated 7 Sep 99, should be revised to reflect the discussions and decisions rendered during this meeting. The current version, dated 2 Dec 99, has been reviewed and approved by all Ad Hoc Group members (**Enclosure 5**). It will be forwarded to WES for their guidance and continuing efforts on the ORMSS Lock Model Testing Program.

8. CELRL has provided WES with all the funds necessary to complete the design and construction of the facility that will house the model. Additional funding has since been forwarded to WES for the design and construction of the lock model. Funding for the Phase 1(a) effort will be forwarded as WES approaches the start of that specific item.

9. The meeting concluded with a visit to the model fabrication shop.

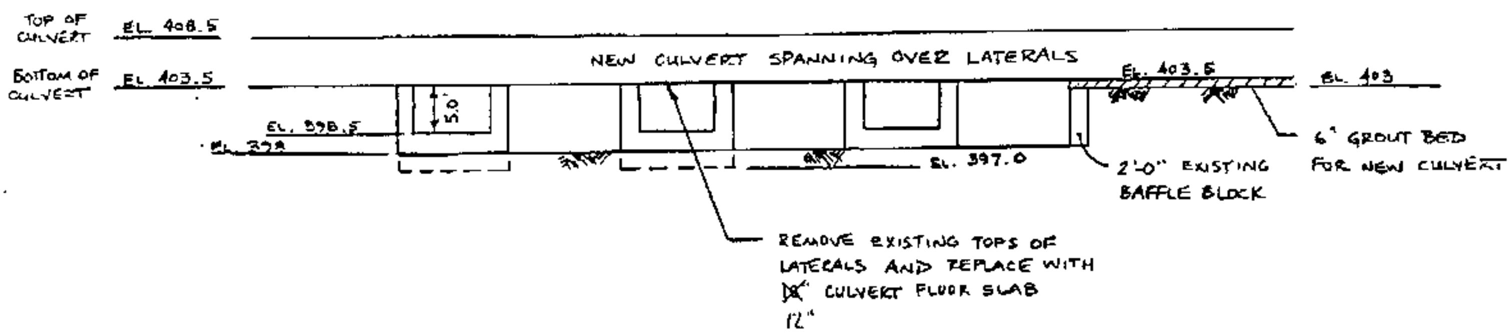
Enclosures
As stated w/o Encl 3

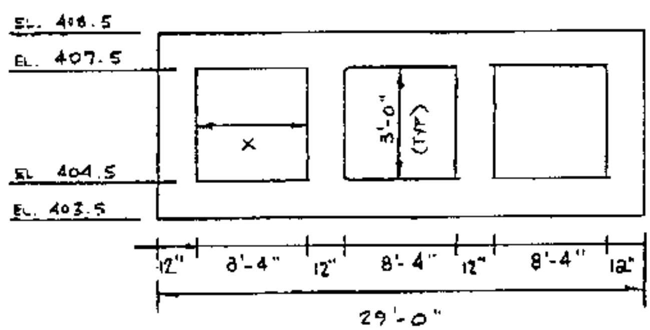
MICHAEL P. FALLON, P.E.
Ad-Hoc Group Chair
CELRD Regional Navigation Design Team

Copies Furnished via web site:
Each Attendee
CELRL-ED/Joe Keith, RNDT Chairman

Determine Maximum Height of Top of Culvert

EL. UPPER POOL ~ 455
EL. LOWER POOL ~ 420
ASSUME MIN. CLEARANCE OF 11.5'





Determine Opening Size to Get 75 ft² of opening

$(3x)(3') = 75\ ft^2$

$x = 8.33'$ or $8'$-$4"$ (Therefore, ℄ to ℄ span length length will be 9'-0")

Normal Load Case $h = 35'$ (normal head)

$w_p = (0.0625\ kcf)(35') = 2.1875\ ksf$ (hydrostatic) $w_d = (0.15\ kips/ft^3)(1')(1') = 0.15\ k$ (dead load)

Determine uniform factored load (consider a 1' slice into paper)

$w_p = \left(2.1875\ \frac{kips}{ft^2}\right)(1') = 2.1875\ kips/ft$

using ACI 318 use following load factors $U_d = 0.9$ $U_\ell = 1.7$

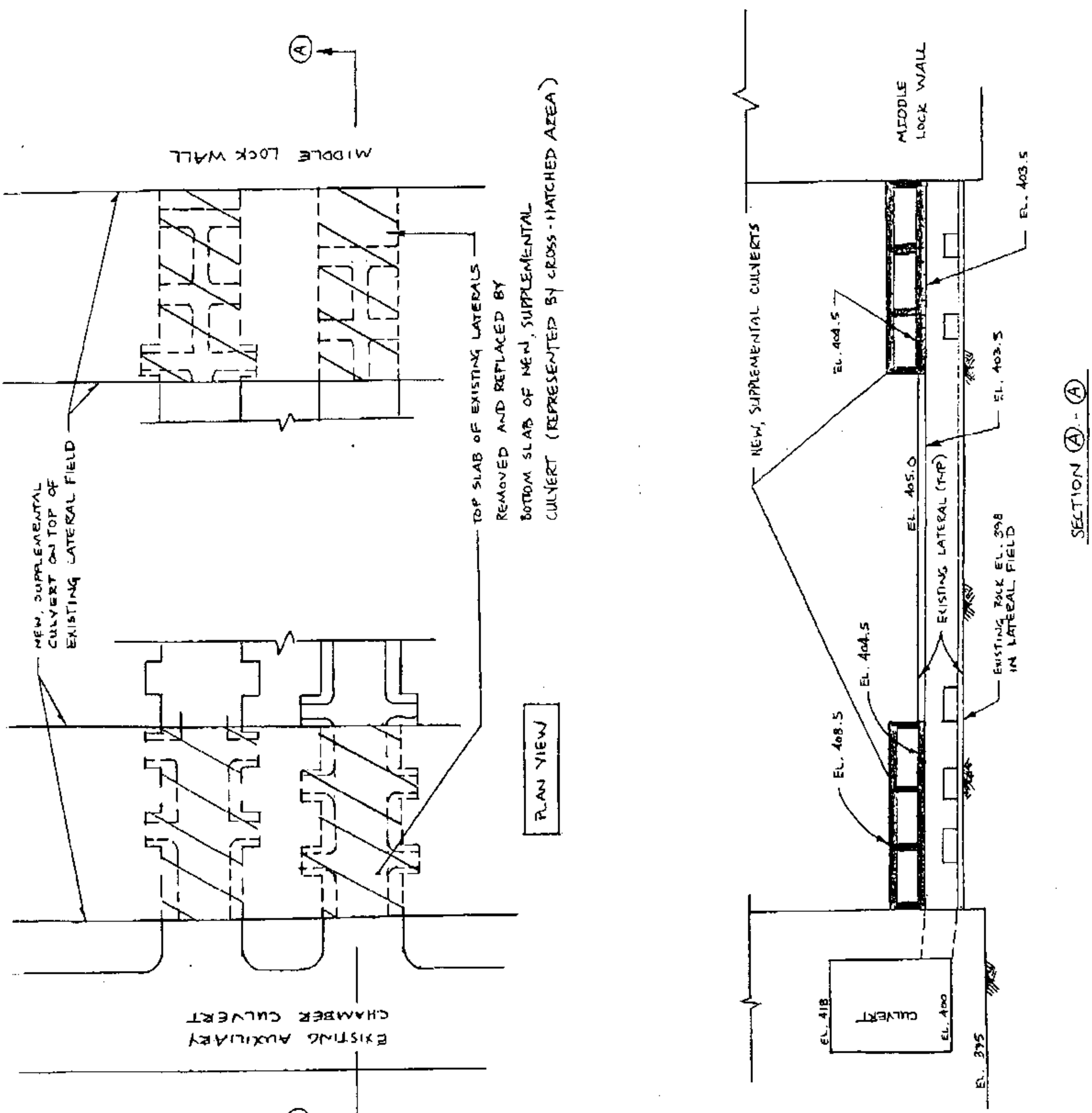
since it helps you against uplift

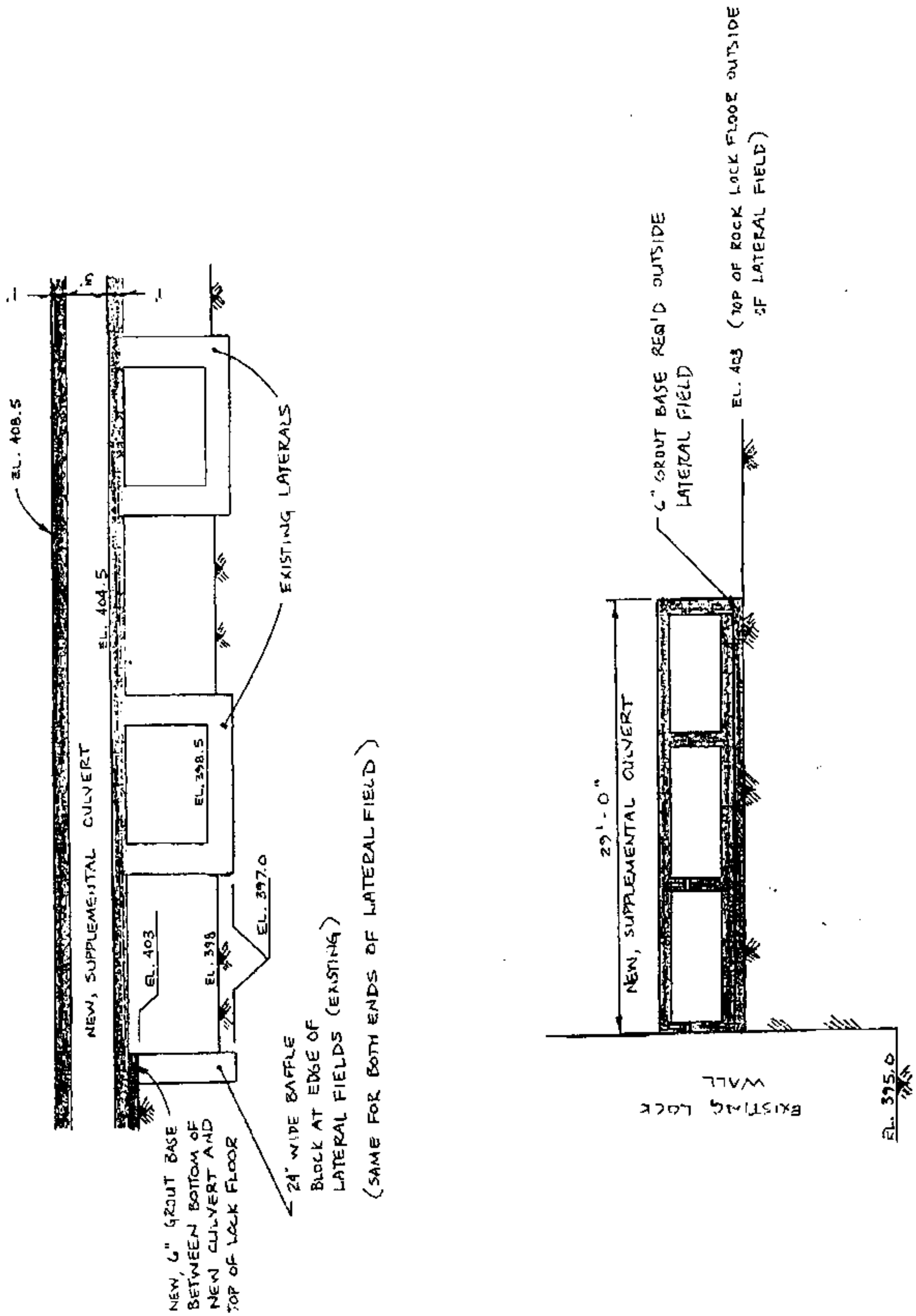
Factored Uniform Load,

$w_u = 1.7\,(2.1875\ kips/ft) - 0.9\,(0.15\ kips/ft) = 3.58\ kips/ft$

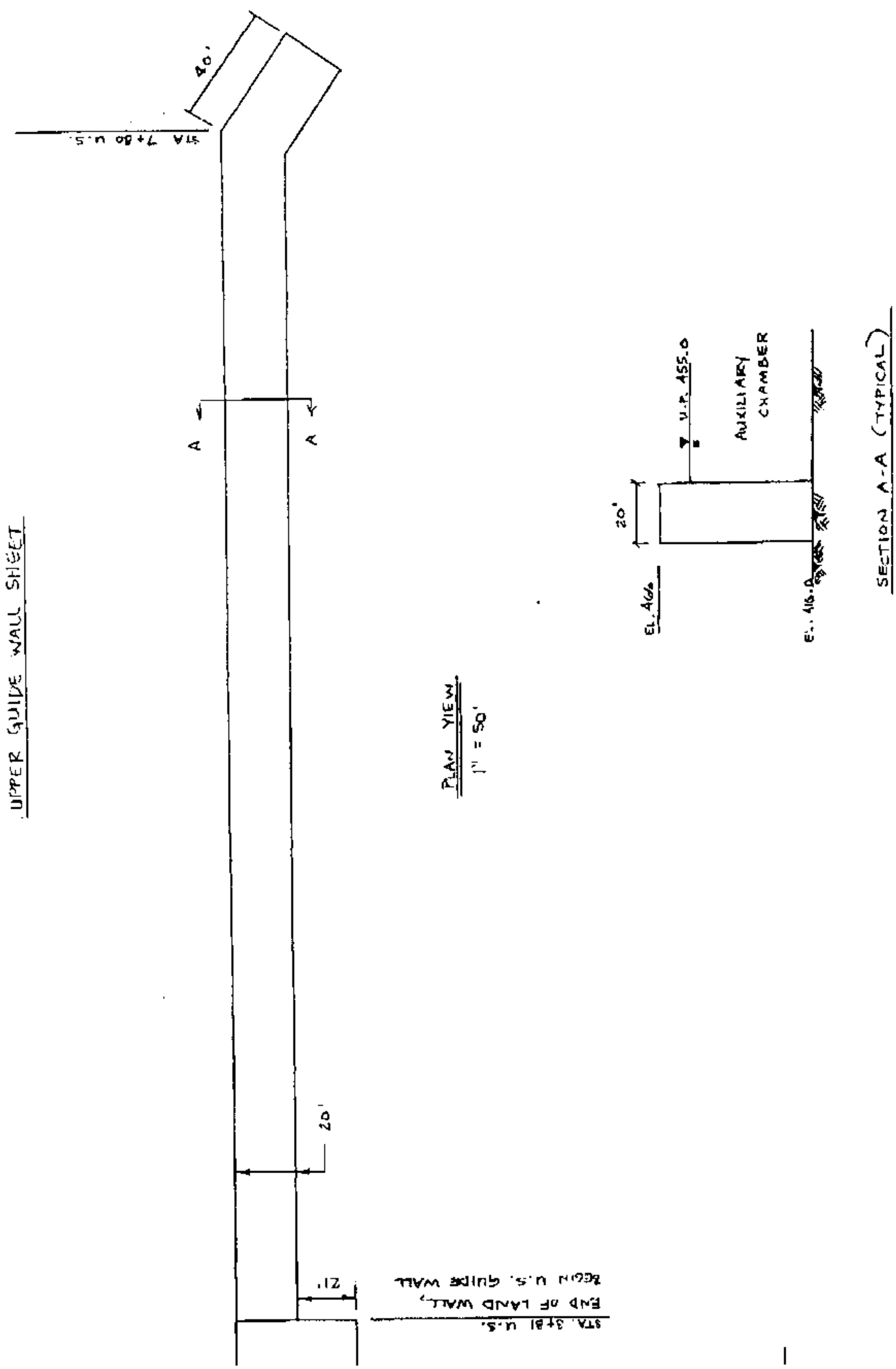
Encl 1

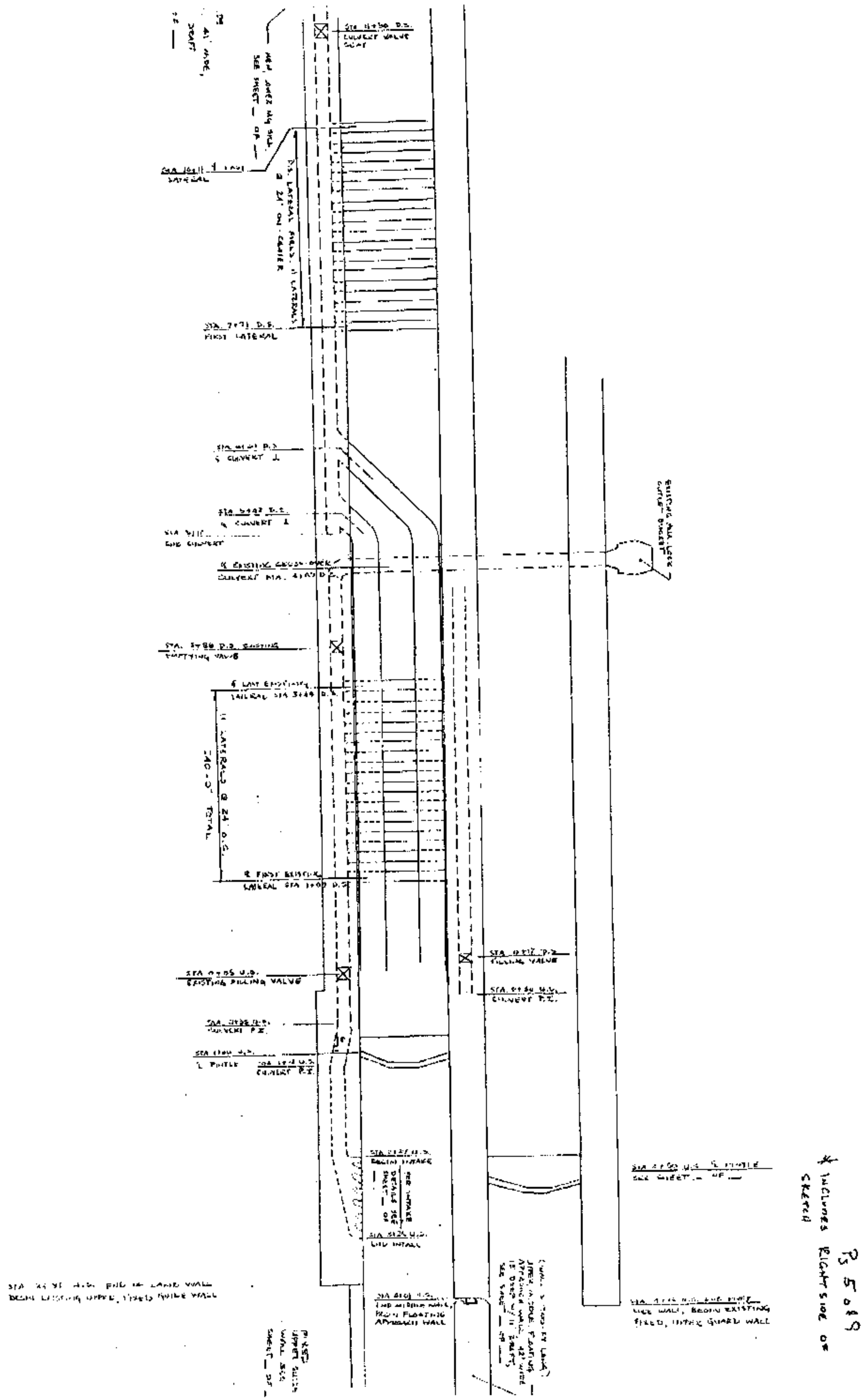
US Army Corps of Engineers Louisville District	Subject: NEW CULVERT / EXISTING LATERAL PLAN AND SECTION SHEET	Page 2 of 9 Pages
		Computed By / Date
		Checked By / Date

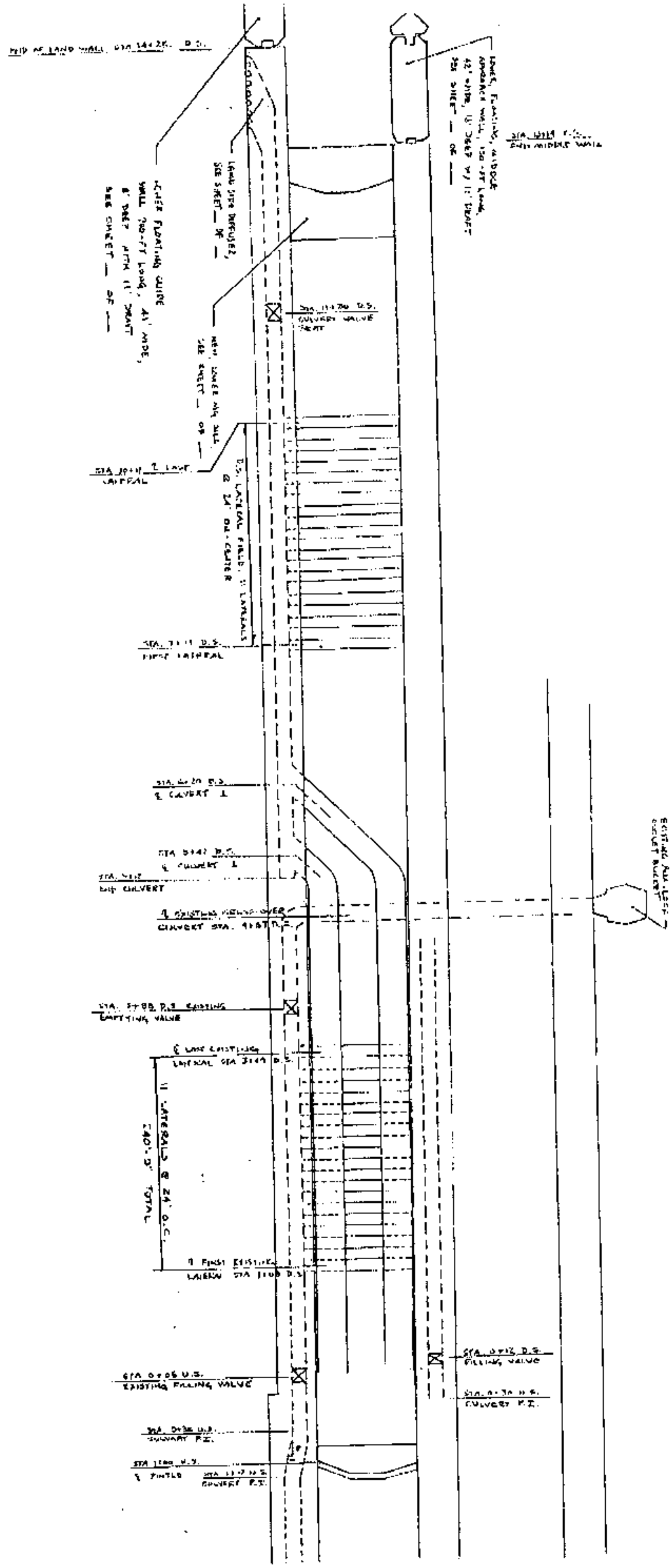



EL. 408.5
NEW, SUPPLEMENTAL CULVERT
EL. 404.5
EXISTING LATERALS
EL. 398.5
EL. 403
EL. 398
EL. 397.0
NEW, 6" GROUT BASE BETWEEN BOTTOM OF NEW CULVERT AND TOP OF LOCK FLOOR
24" WIDE BAFFLE BLOCK AT EDGE OF LATERAL FIELDS (EXISTING)
(SAME FOR BOTH ENDS OF LATERAL FIELD)
6" GROUT BASE REQ'D OUTSIDE LATERAL FIELD
EL. 403 (TOP OF ROCK LOCK FLOOR OUTSIDE OF LATERAL FIELD)
29'-0"
NEW, SUPPLEMENTAL CULVERT
EXISTING LOCK WALL
EL. 395.0

US Army Corps of Engineers Louisville District	Subject: ORMSS	Page 4 of 9 Pages
		Computed By / Date
		Checked By / Date




D.S. LATERAL FIELD, 11 LATERALS
@ 24' ON CENTER
11 LATERALS @ 24' O.C.
240'-0" TOTAL
EXISTING FILLING VALVE
FILLING VALVE
P3 5 of 9
* INCLUDES RIGHT SIDE OF SKETCH



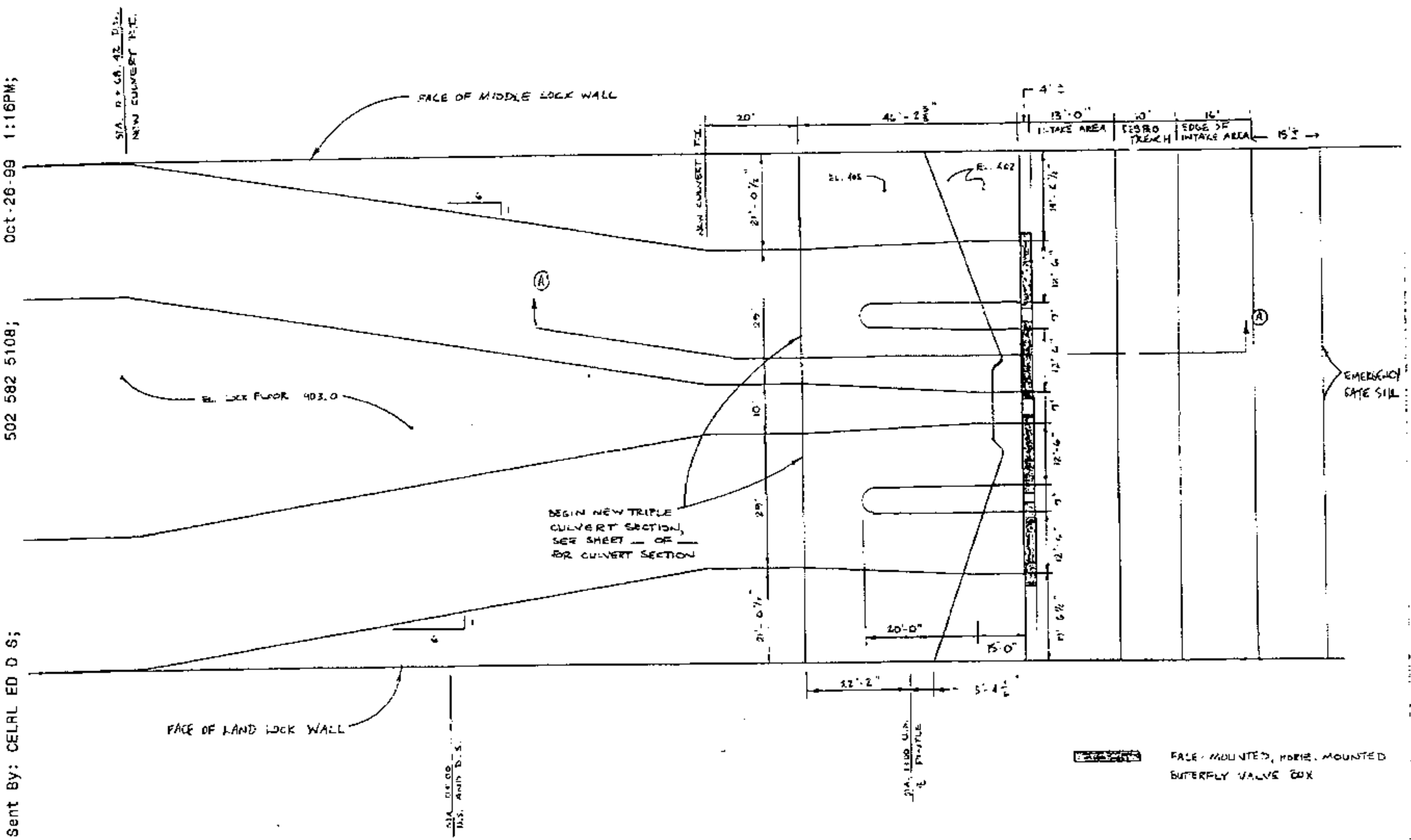
Pg 6 of 9

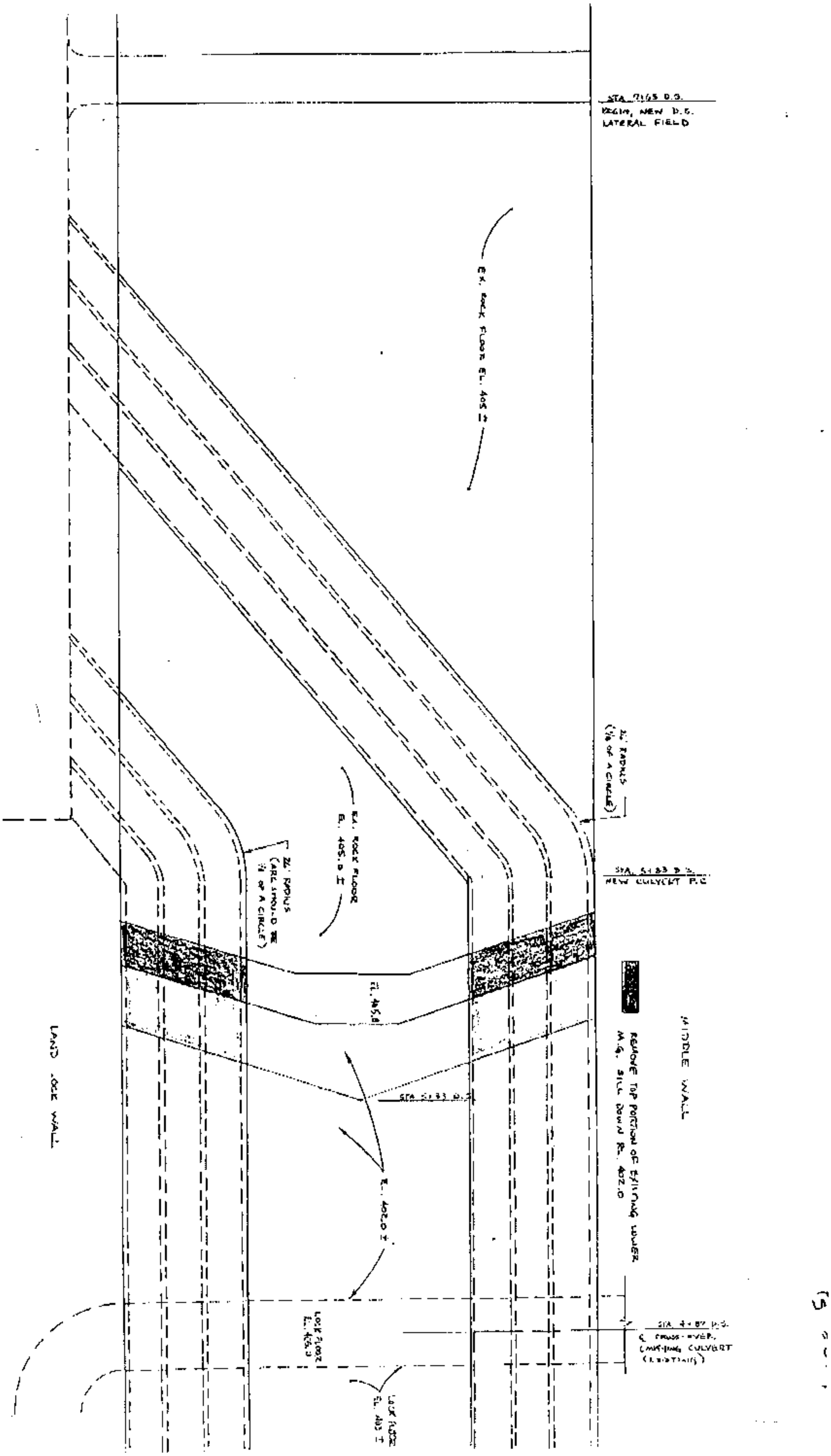
* INCLUDES LEFT SIDE OF SKETCH

US Army Corps of Engineers Louisville District	Subject	Page
		Computed By
		Checked By

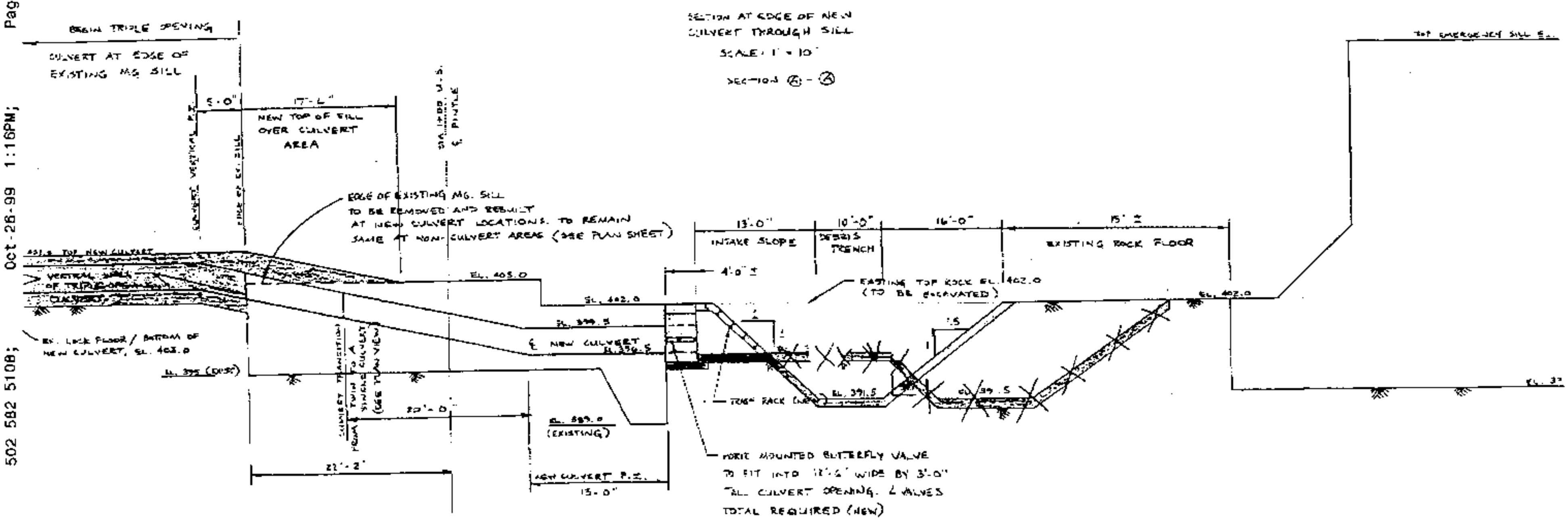
US Army Corps of Engineers Louisville District	Subject AUXILIARY LOCK UPPER MITER GATE SILL PLAN AND SECTIONS WITH NEW, THRU-THE-SILL FILLING VALVES	Page 7 of 9 Pages	
		Computed By	Date
		Checked By	Date

~~SCALE~~




STA. 71+65 D.S.
BEGIN NEW D.S. LATERAL FIELD
EX. ROCK FLOOR EL. 405 ±
24' RADIUS (1/8 OF A CIRCLE)
STA. 51+83 D.S.
NEW CULVERT P.C.
EX. ROCK FLOOR EL. 405.0 ±
24' RADIUS (ARC SHOULD BE 1/8 OF A CIRCLE)
EL. 405.8
REMOVE TOP PORTION OF EXISTING LOWER M.G. SILL DOWN EL. 402.0
MIDDLE WALL
LAND LOCK WALL
EL. 402.0 ±
STA. 44+87 D.S.
CROSS-OVER, CURVED CULVERT (EXISTING)
LOCK FLOOR EL. 405.0
LOCK FLOOR EL. 403 ±

TS 9 of 7


SECTION AT EDGE OF NEW
CULVERT THROUGH SILL
SCALE: 1" = 10'
SECTION (A) - (A)
BEGIN TRIPLE OPENING
CULVERT AT EDGE OF
EXISTING MG. SILL
5'-0"
17'-4"
NEW TOP OF FILL
OVER CULVERT
AREA
EDGE OF EXISTING MG. SILL
TO BE REMOVED AND REBUILT
AT NEW CULVERT LOCATIONS. TO REMAIN
SAME AT NON-CULVERT AREAS (SEE PLAN SHEET)
EL. 405.0
EL. 402.0
EL. 399.5
℄ NEW CULVERT
EX. LOCK FLOOR / BOTTOM OF
NEW CULVERT, EL. 403.0
(EXISTING)
22'-2"
20'-0"
NEW CULVERT P.I.
15'-0"
4'-0" ±
13'-0"
INTAKE SLOPE
10'-0"
DEBRIS
TRENCH
16'-0"
15' ±
EXISTING ROCK FLOOR
EXISTING TOP ROCK EL. 402.0
(TO BE EXCAVATED)
1.5
1
EL. 391.5
EL. 402.0
TOP EMERGENCY SILL EL.
FORCE MOUNTED BUTTERFLY VALVE
TO FIT INTO 12'-6" WIDE BY 3'-0"
TALL CULVERT OPENING. 4 VALVES
TOTAL REQUIRED (NEW)

Bob Willis - 502 625 7473

ISO 9001
Certificate Number: 32314

Louisville District's

Engineering
Division

FACSIMILE HEADER SHEET

Name	Office Symbol	Office Telephone	Fax No.
FROM: Brian Huston	CELRL-ED-D-S	502 582 6005	502 582 5108
TO: Russell Witten	Huntington District		304 529 5209

No. Pages (including this header)	Releaser's Signature	Date
10		10/26/99

REMARKS

9 Nov 99
D. SCHAAF, LRL

Supplemental Culvert (Triple Culvert Through-the-Sill) Cost Estimate for "Generic" Model

The cost estimate developed below is for a through-the-sill supplemental culvert system specific to the quantities at Markland which is set up very similar to Greenup. However, the culvert design was determined using properties at Greenup. Sources of information regarding unit costs came from a variety of places, such as the J.T. Myers estimate for the wrap around culvert construction, 1997 McAlpine DM with a through-the-sill intake and central culvert system, as well as information from recent contractor quotes.

1997 to 1999
Cost Factor
1.0494

Mobilization/Demobilization

Assume same mobilization/demobilization costs as per Phase 2 construction of wrap around culvert

	Units	Unit Cost	Quantity	Total Cost	Source of Information
Total Mob/Demob	LS	$808,543	1	$808,543	J.T. Myers Estimate

Site Preparation

This item should be significantly less than the site preparation required for a wrap around culvert. Assume costs will only run approximately 25% of those required for site preparation at J.T. Myers for wrap around culvert construction.

Total Site Preparation	LS	$283,104	1	$283,104	J.T. Myers Estimate

Limestone Excavation

Item includes excavating rock, loading, hauling, and unloading

US of Upper MG Area	cy	$52.84	1052.8	$55,627	McAlpine 1997 DM
DS of Lower MG Area	cy	$52.84	402.3	$21,256	
				$76,884	

Triple Opening Supplemental Culvert Construction

Item includes placement of formed concrete, associated rebar, concrete finishing, etc.

Top Slab	cy	$197.32	2024.6	$399,491	McAlpine 1997 DM for
Walls	cy	$236.70	726.2	$171,893	construction of central
Bottom Slab	cy	$146.96	2427.6	$356,755	culvert system
				$928,140	
Using the JT Myers Estimate of $371.74/cy for construction of the new laterals as opposed to McAlpine unit costs				$1,925,018	JT Myers Estimate

Dewatering of Lock Chamber for Construction

Assume same cost as for dewatering in JT Myers estimate

Dewatering	LS	$ 940,372	1	$940,372	JT Myers Estimate

Permanent Access Road, Upgrade Existing Road, and Parking

Assume same cost for this line item as for J.T. Myers estimate for construction of Phase 2

Upgrade Roads	LS	$674,431	1	$674,431	JT Myers Estimate

Trash Rack for Intake

Assume same cost as McAlpine Through-the-Sill Design

Trash rack	LS	$712,543	1	$712,543	McAlpine 1997 DM

Demolition of Existing Concrete

Assume saw cut with diamond wire saw, handling, crushing, and storage of demolished concrete
For upper MG sill, saw cut and demolished down to elevation 395 for a width of approximately 80 feet

Upper Miter Gate Sill	sf	$62.50	872	$54,500	Recent Quote for Cutting
	cy	$100	1398	$139,800	McAlpine 1997 DM
Top Slab of Existing Laterals	sf	$62.50	792	$49,500	
	cy	$100	425.3	$42,530	
Top Slab of Cross-Over Culvert	sf	$62.50	264	$16,500	
	cy	$100	141.8	$14,180	
Lower Miter Gate Sill	sf	$62.50	120	$7,500	

ENCL 2

cy	$100	64.4	$6,440	
			$330,950	

Remove, Store, and Reinstall Upper Miter Gates During Sill Reconstruction
Cost was developed to be same as cost and closure matrices for the ORMSS study

Daily Fleet Cost with Gate Crane	day	$20,750	30	$622,500

Rebuild Upper Miter Gate Sill
Assume sill was demolished to a base elevation of 395.0 for a width of 80 feet. Use a unit cost of $371.74 for formed concrete from the J.T. Myers estimate and figure total cubic yards required.

Total Area Rebuilt W/O Culverts	cy	$371.74	1473.5	$547,759	J.T. Myers Estimate
Subtract Area of Culverts	cy	$371.74	-287.4	-$106,838	
Provide Slabs at Intake Area	cy	$146.96	173.5	$25,497	McAlpine 1997 DM
				$466,418	

Butterfly Valves
This cost is roughly based upon the estimate for 4 larger valves estimated for the through-the-sill option in the McAlpine 1997 DM

Total for 4 Valves with a Spare	LS	$800,000	1	$800,000	McAlpine 1997 DM

Through-the-Sill Supplemental Culvert Cost

Estimated Construction Cost	$6,643,884	
Contractor Overhead and Profit	$1,328,777	(Assume 20% as per Martin Lockard)
Cost Without Contingencies	$7,972,661	
Apply 30% Contingency	$2,391,798	(30% used versus 22% from J.T. Myers estimate)
Through-the-Sill Construct Cost	$10,364,459	
Fish and Wildlife Facilities	$362,756	(Use 3.5% as general guide)
Planning and Engineering Design	$1,554,669	(15% assumed)
Construction Management	$777,334	(7.5% assumed)
Through-the-Sill Total Cost	**$13,059,219**	

Supplemental Culvert Cost Comparison Information vs. Wrap Around Culvert Option from J.T. Myers

The cost comparison for providing a supplemental culvert system with through-the-sill intakes needs to be compared to the cost of providing a wrap around culvert in order to determine the differences between the two systems. For comparison, the cost estimate should generally compare what the Phase 2 costs for the wrap around culvert system would be versus the through-the-sill system. Therefore, the assumption is that Phase 1 costs will remain the same and the differences will be measured only with the Phase 2 costs.

For the J.T. Myers site, the following items are INCLUDED in the Phase 1 construction and cost estimate in order to limit interruption of navigation traffic in future years:

New lateral field in the extended downstream end of the chamber
Landside diffuser for outlet system
Riprap for downstream diffuser
Emptying valve in the land wall
Knockout in land wall for future wrap around culvert addition

Prior to information regarding recent bidding on Olmsted, Braddock, etc., the last construction cost estimate for Phase 1 only at J.T. Myers was estimated at $107.9 million including contingencies. Adding approximately 15% for PED, 7.5% for construction management, and 3.5% for Fish and Wildlife brought the Phase 1 final cost estimate to $136.0 million.

For Phase 2 at J.T. Myers, the following major items with construction costs without contingencies were identified (again, costs estimates reflect numbers prior to any recent bidding information):

Mobilization/Demobilization	$ 808,543
Site Preparation	$1,132,417
Permanent Access Roads/Parking	$ 674,431
F/E System, Shoring	$4,795,283
F/E System, Unwatering	$ 739,380
F/E System, Soil Excavation	$1,997,544
F/E System, Rock Excavation	$ 443,797
F/E System, Backfill (All)	$1,542,790
F/E System, Trashrack	$ 176,820
Concrete, Intake Monolith	$ 915,941
Concrete, Thrust Block	$ 858,258
Concrete Culvert, 16.5' Diameter	$2,789,208
Ice and Debris Floating Boom	$ 226,394
Culvert Valves, Blkhds, Machinery	$ 496,092
Culvert Valve Structure	$1,659,113

Drilled Shaft Wing Wall	$1,279,327	
Relocate Existing Utilities	$ 151,638	
Hydraulic Piping System	$ 193,105	
All Other F/E Features	$ 286,291	
Relocate Existing Mooring Facility	$2,410,612	
Sub-Contractor Mark-up and Other	$1,986,571	
Cost Without O & P	$26,290,943	
Contractor Overhead/Profit	$ 1,973,057	(Approx. 7.5%)
Cost Without Contingencies	$28,264,000	
Contingency (Approx. 22%)	$ 6,274,000	(Approx. 22%)
Phase 2 Construction Cost	$34,538,000	
Fish and Wildlife Facilities	$ 1,208,000	(Approx. 3.5%)
Planning, Engineering, and Design	$ 5,181,000	(Approx. 15%)
Construction Management	$ 2,730,000	(Approx. 7.9%)
Total Cost for J.T. Myers Phase 2 With Wrap Around Culvert	**$43,657,000**	

For the cost estimate for the Through-the-Sill Supplemental Culvert System, several differences in items and costs must be delineated. Since the downstream laterals are assumed to be installed during the first phase, along with the land side diffuser, emptying valve, and associated riprap, these items do not need to be estimated for the through-the-sill option since it also will utilize each of these items. The major features which must be costed out for the Through-the-Sill option are as follows:

Mobilization and Demobilization. This cost was conservatively assumed to be the same as for the J.T. Myers second phase effort that requires the construction of a long, wrap around culvert and thus, will require more specialized equipment.

Site Preparation. Again this effort should be less extensive than the preparation required for the wrap around culvert since the majority of all work will be done in the existing chamber and extended chamber footprint. Since this was a major cost item for the wrap around culvert option, it was assumed that this item would run only 25% of the cost for the wrap around option.

Dewatering of Lock Chamber for Construction. This cost was again developed from the J.T. Myers Wrap Around Culvert cost estimate. However, most of the construction during Phase 2 of wrap around culvert plan does not require dewatering of the chamber. For the through-the-sill option, the chamber must be closed for an extended period in order to construct the new culverts with formed concrete. Assume the effort will require the auxiliary chamber to be dewatered for a year compared to the 3 months for the wrap around option. Therefore, multiply the cost by 4 times for the through-the-sill plan.

Permanent Access Road, Upgrade Existing Roads, and Parking. This line item was assumed to be the same as the J.T. Myers estimate for the second phase of construction.

Limestone Excavation. This item is required to get the necessary foundation elevation where the lock floor is too high such that a proper draft (assumed to be 11.5 feet) is maintained. Other excavation will be required to construct the intake and debris trench upstream of the upper miter gate sill. Since this is very similar to the option studied under the 1997 McAlpine DM, the unit costs were obtained from this source. They were compared to the rock excavation unit costs from the J.T. Myers estimate and found to be in the same range. It should be noted that this item may not be required at J.T. Myers since there is more applicable room for draft with the existing elevations.

Demolition of Existing Concrete. This item is required for the partial demolition of the existing upstream miter gate sill in order to build the through-the-sill intake. The cost was developed by taking a recent quote from diamond wire saw cutting on a square foot basis and then adding in the demolition of the concrete volume once it was cut. Using the saw cutting on a per square foot basis, along with the handling, crushing, and storage of the removed concrete, it turned out to be an average unit price of $163/cy which is higher than the 1997 McAlpine DM (which used a bulk value of $75/cy). However, a higher cost should be assumed given the areas where demolition will be occurring. Again, some of this may not be required at J.T. Myers with the existing elevations at that site.

Trash Rack for Intake. The same unit cost updated to 1999 level was used as for the McAlpine DM.

Cost of Triple Opening Supplemental Culvert. Again, these unit costs were comparable to the option being investigated under the McAlpine 1997 DM. This estimate broke down formed concrete unit costs for construction of the top slab, base slab, and walls for a central culvert system. The same unit costs were assumed and updated to October 1999 levels.

Rebuild Upper Miter Gate Sill. Unit costs for formed concrete from the J.T. Myers estimate, which were considerably higher than the updated McAlpine unit costs, were used to determine the approximate cost to rebuild the sill after demolition.

Cost to Remove Upper Miter Gates, Store, and Reinstall. For the year of that the chamber is time each to remove the miter gate and then place them back in after the new sill is constructed dewatered for construction of the supplemental culverts, assumed the gates are taken out of the upper area and stored on the storage pier. Assume this will take approximate 15 days of fleet. From the ORMSS study, it was assumed that LRL Operations daily fleet costs would run approximately $41,500 per day for major dewaterings using the gate lifter crane. Assume only a half-fleet will be necessary since no maintenance costs should be assumed to be part of this construction cost, only the cost to move and store the gates.

Butterfly Valves. This cost was based upon the through-the-sill option from the McAlpine DM. The costs were generally proportioned to reflect the smaller size compared to the valves from McAlpine.

A summary of each cost item is supplied below for the Through-the-Sill option:

Mobilization/Demobilization	$ 808,543
Site Preparation (25% of JTM Estimate)	$ 283,104
Dewatering of Lock Chamber	$ 940,372
Access Road, Upgrade Exist Road, Parking	$ 674,431
Limestone Excavation	$ 76,884
Demolition of Existing Concrete	$ 330,950
Trash Rack for Intake	$ 712,543
Triple Opening Supplemental Culvert	$ 928,410
Rebuild Upper Miter Gate Sill	$ 466,418
Remove, Store, Reinstall Upper Gates	$ 622,500
Butterfly Valves	$ 800,000
Cost Without Contractor O/P	$6,643,884
Assume 20% Contractor O/P	$1,328,777
Cost Without Contingencies	$7,972,661
Assume 30% Contingency	$2,391,798
Cost With Contingency Added	$10,364,459
Assume 3.5% for Fish and Wildlife	$ 362,756
Assume 15% for PED	$ 1,554,669
Assume 7.5% for Construction Mgmt.	$ 777,334
Total Cost for Through-the-Sill Option	**$13,059,219**

Reviewing the cost estimates at both sites easily shows where the savings are generated by going through-the-sill. The largest savings are generated by less extensive Site Preparation, no excavation/shoring/unwatering required for a wrap around culvert system, no drilled shaft wing wall, not having to relocate the existing fleet mooring facility, and all other associated costs tied to the construction cost estimated (such as PED, Construction Mgmt., and Fish and Wildlife).

CELRH-EC-WH

26 November 1999
Smith/5523

MEMORANDUM FOR RECORD

SUBJECT: Ohio River Mainstem Study Numerical Model Investigations

1. The Huntington District, COE was tasked to determine the applicability and viability for physical model study investigations of a specific alternative to filling and emptying systems for lock projects within the Ohio River Mainstem Study Program. This particular alternative, congruent with proposed lock extensions, includes the addition of supplemental intakes, culverts and laterals. The supplemental filling and emptying (F/E) system would consist of through-the-sill intakes and two F/E culverts which transition to a single culvert supplying an additional bottom lateral field manifold system. In order to achieve a more balanced water surface within the lock chamber during filling and emptying, the supplemental system would be configured to supply the lower portion of the lock extension. A reverse-mounted tainter valve situated within the extended lock chamber wall would maintain flow through the supplemental system. Thereby, filling and emptying of the extended lock chamber would be facilitated through the existing intake structure and remaining F/E system as well as the additional culverts and supplemental F/E features.

2. Numerical analyses were conducted for the JT Myers L&D, which possess an 18 feet lift and a submergence of 19.5 feet over the existing F/E laterals. A total barge draft of 12 feet was used during the analyses. Varied vertical dimensions of the supplemental culverts were utilized such that the limited draft would not be compromised. Modifications to the existing lower miter gate sill and cross over would be necessary in order to provide adequate submergence for the supplemental system. Varying of the vertical dimension also provided additional open area for flow conveyance. A maximum horizontal dimension of 29 feet was used for the supplemental culverts spanning the upper portion of the lock chamber. The geometric configurations of the supplemental system would be altered in order to transition into a single culvert situated within the extended lock chamber wall. The supplemental culvert was sized to a total surface area of 150-, 250-, and 300-ft^2 for sensitivity analyses of the system. Since the supplemental culverts will be placed directly on top of the existing F/E laterals (against the lock walls), interference with the existing F/E laterals is expected.

3. Numerical modeling techniques were utilized to evaluate the proposed lock extension filling and emptying alternative. LOCKSIM (LOCK SIMulator) is a hydraulic numerical computer model developed at the Tennessee Valley Authority (TVA's) Engineering Laboratory for simulation of one-dimensional transient

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filling and emptying flow in navigation locks. The program permits a more detailed numerical analysis of the F/E system compared with traditional methods.

4. Anticipated filling times for a typical 600-feet lock extension without supplemental F/E system range from 16 to 18 minutes. A 600-feet lock extension without supplemental F/E system was considered as the base condition. Results of the analyses indicate that filling times can be reduced from the base condition through implementation of the additional F/E features. However, modifications to the existing valve operating schedule would be required. Resultant fill times and subsequent hawser forces are included as an attachment to this memorandum. Over-travel of the valve was not considered during the analyses, therefore, the resultant fill time will be slightly increased. Providing an additional driving head through the supplemental system does result in lower fill times. Due to submergence constraints and in an attempt to lessen the interference with the existing F/E system, varying the geometric configurations of the supplemental system components may yield more satisfactory results. Considering hydraulic feature system ratios and their design head, results of numerical analyses for other lock projects within the system will be relative to their overall site specific base condition. Therefore, the fill time deltas from the base condition in the cited analyses should be applicable for other projects. More detailed analyses are warranted to determine the adverse effects upon intake conditions due to implementation of the project features as well as expected interference with the existing F/E system. In addition, a numerical solution provides limited analyses as to the effects of transition form losses for those expected with this alternative. Specific site conditions must be taken into consideration when evaluating the alternative.

5. In conclusion, the cursory investigation did determine that the potential exists for reductions in fill times due to the implementation of the supplemental F/E features. Comprehensive effects of the proposed alternative are dependent upon individual site conditions and should be evaluated as such. Additional studies are warranted to determine the total system effects of the proposed alternative relative to hydraulic and structural concerns. In particular, detailed physical hydraulic modeling would be required to determine the effects of the interference of the existing laterals as well as physical and hydraulic transition areas of the supplemental system.

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Hydrology and Hydraulic Section

JT Myers (18 feet lift)
Without Supplemental F/E System

Valve Time (minutes)	Fill Time (minutes)	Hawser Forces (tons)
2.00	14.13	10.52
3.00	14.75	10.01
4.00	15.30	6.18
5.00	15.87	3.48
6.00	16.45	3.16
7.00	17.00	3.14
8.00	17.56	2.42

JT Myers (18 feet lift)
Additional 150 sf. Supplemenatal Culvert Area

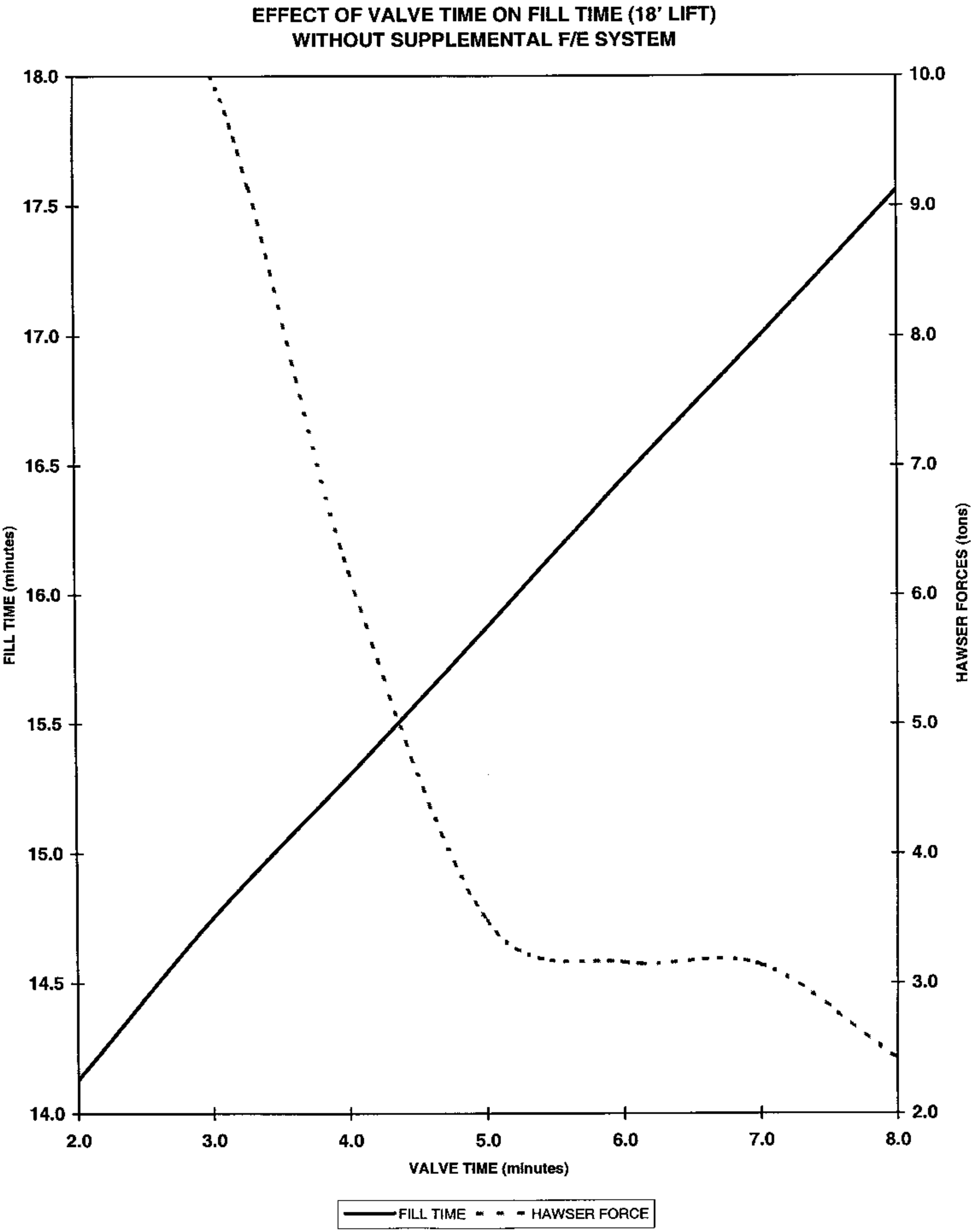
Valve Time (minutes)	Fill Time (minutes)	Hawser Forces (tons)
2.00	9.96	6.65
3.00	10.50	5.61
4.00	11.05	3.55
5.00	11.60	2.12
6.00	12.13	1.60

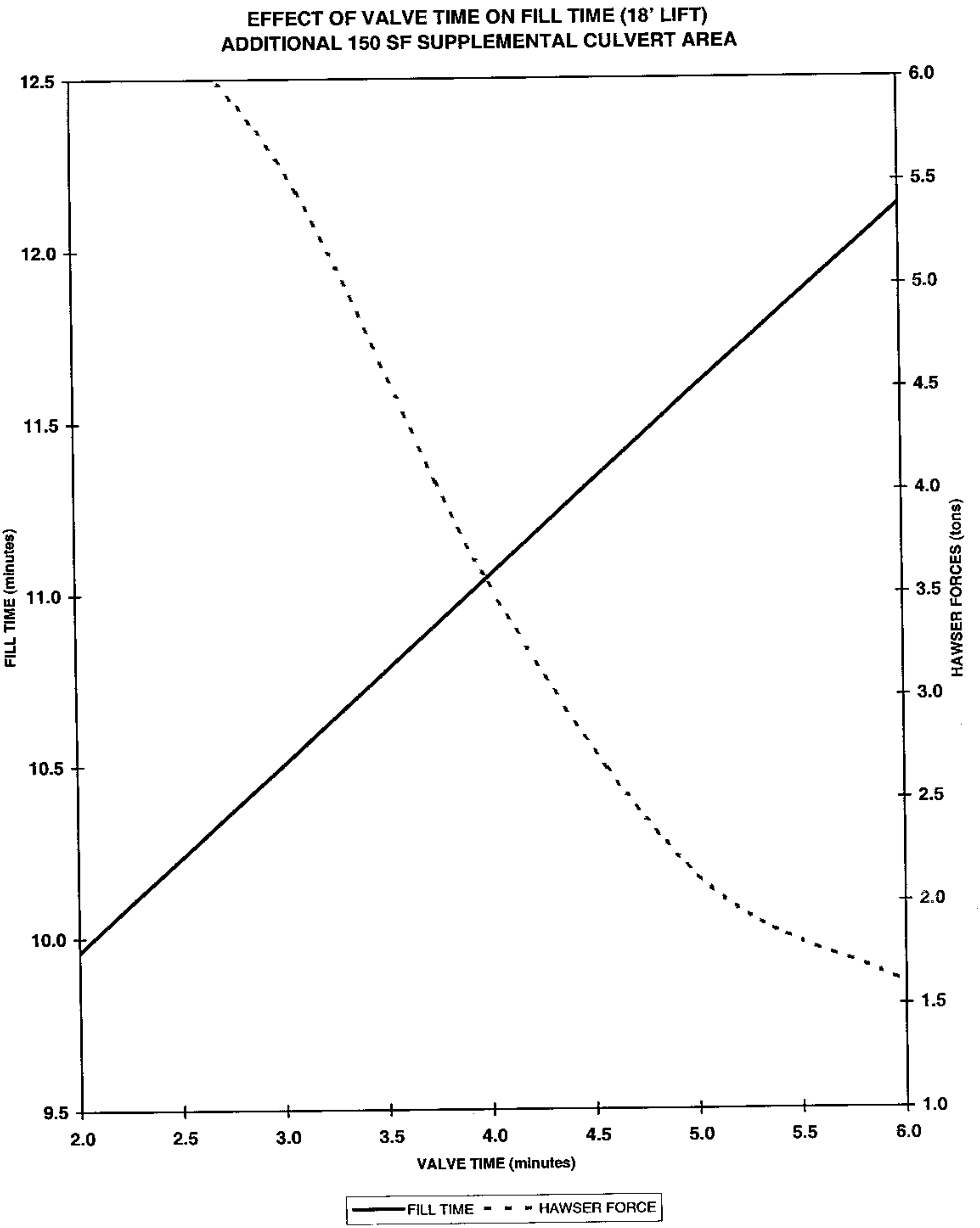
JT Myers (18 feet lift)
Additional 250 sf. Supplemenatal Culvert Area

Valve Time (minutes)	Fill Time (minutes)	Hawser Forces (tons)
2.00	7.58	5.40
3.00	8.20	3.32
4.00	8.79	2.49
5.00	9.37	1.59
6.00	9.97	1.55

JT Myers (18 feet lift)
Additional 300 sf. Supplemenatal Culvert Area

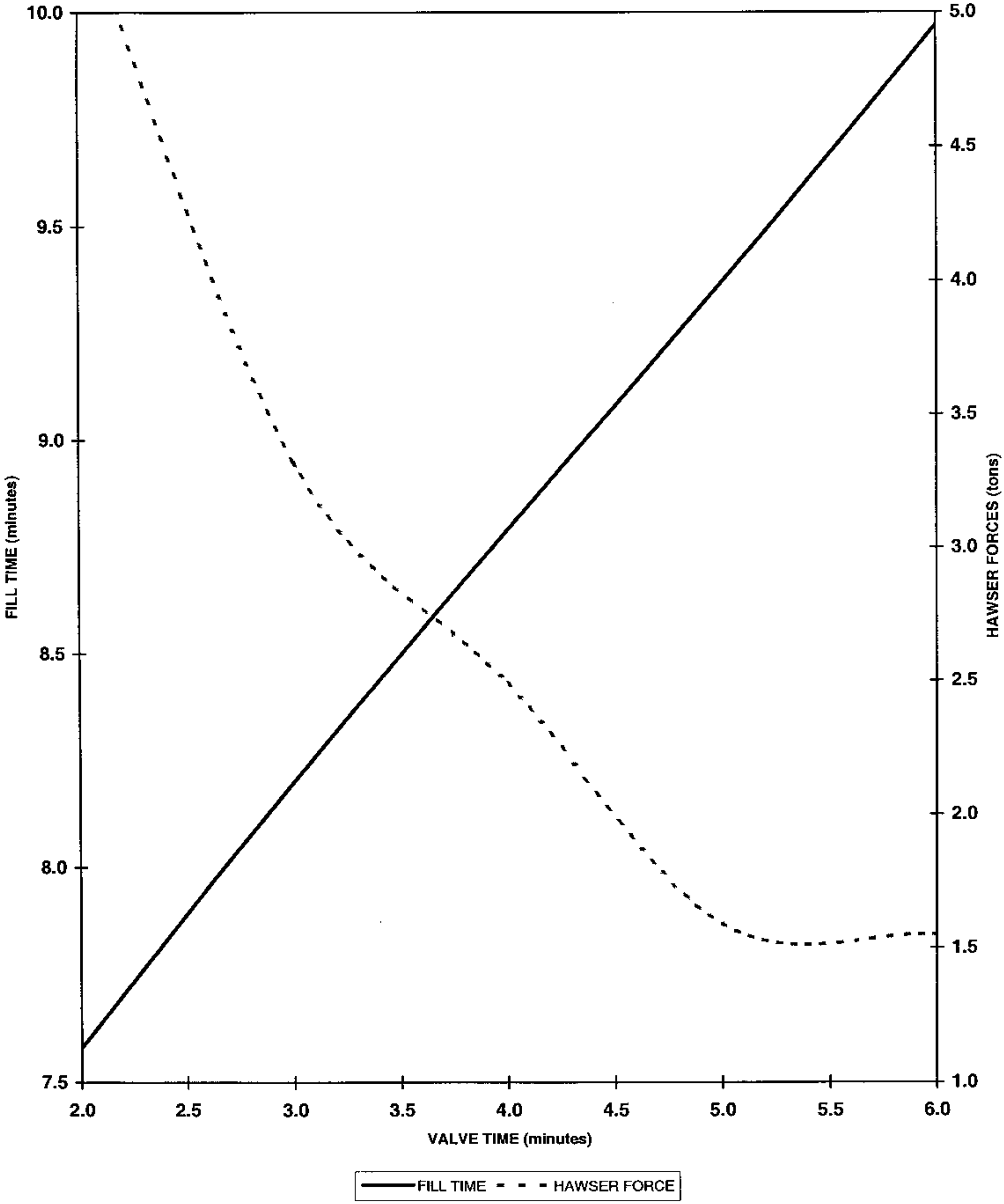
Valve Time (minutes)	Fill Time (minutes)	Hawser Forces (tons)
2.00	7.20	6.94
3.00	7.77	4.00
4.00	8.38	3.00
5.00	9.00	2.05
6.00	9.62	1.80

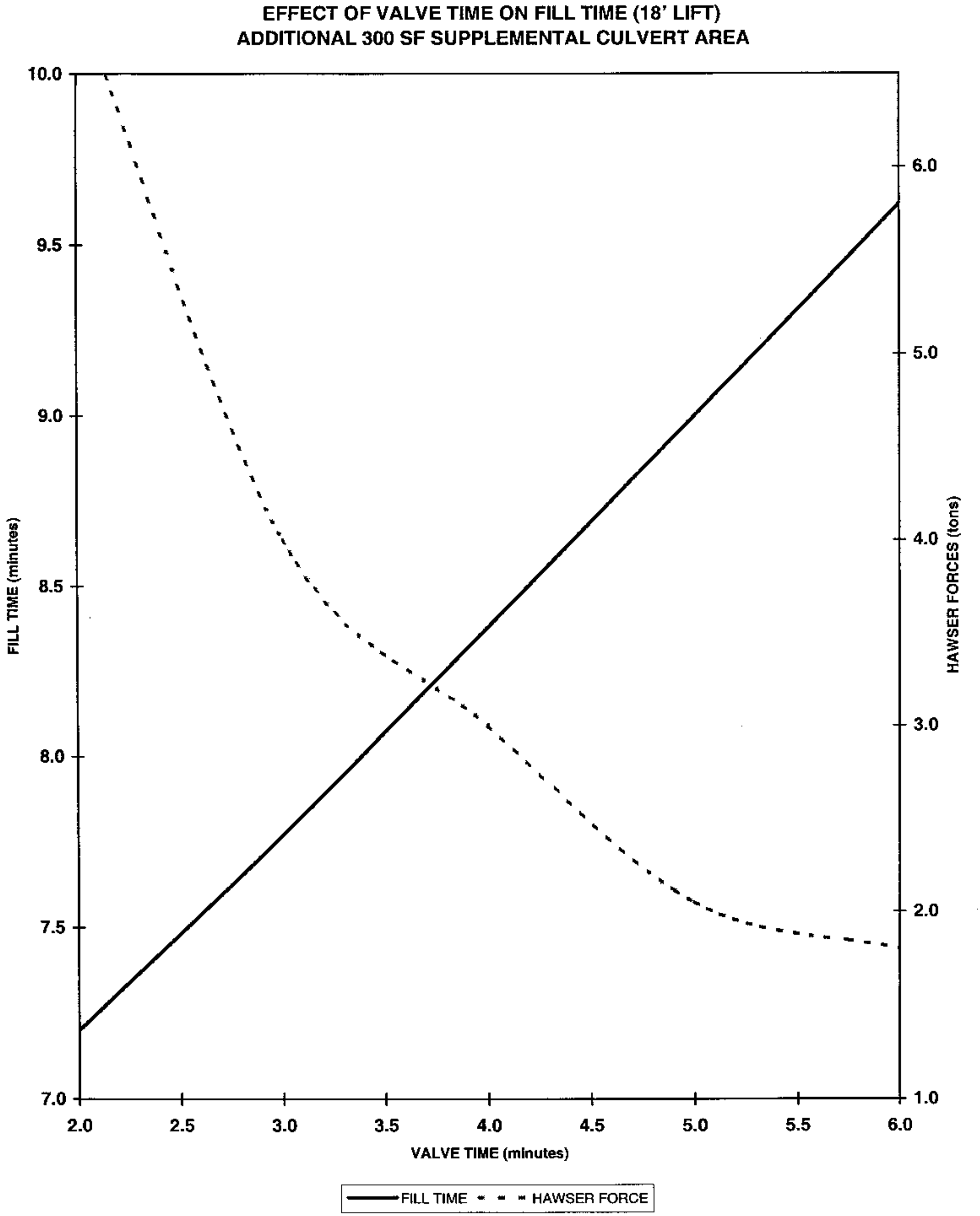

EFFECT OF VALVE TIME ON FILL TIME (18' LIFT)
WITHOUT SUPPLEMENTAL F/E SYSTEM
FILL TIME (minutes)
HAWSER FORCES (tons)
VALVE TIME (minutes)
18.0
17.5
17.0
16.5
16.0
15.5
15.0
14.5
14.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
FILL TIME
HAWSER FORCE



EFFECT OF VALVE TIME ON FILL TIME (18' LIFT)
ADDITIONAL 150 SF SUPPLEMENTAL CULVERT AREA
FILL TIME (minutes)
HAWSER FORCES (tons)
VALVE TIME (minutes)
12.5
12.0
11.5
11.0
10.5
10.0
9.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
FILL TIME
HAWSER FORCE

EFFECT OF VALVE TIME ON FILL TIME (18' LIFT)
ADDITIONAL 250 SF SUPPLEMENTAL CULVERT AREA




EFFECT OF VALVE TIME ON FILL TIME (18' LIFT)
ADDITIONAL 300 SF SUPPLEMENTAL CULVERT AREA
FILL TIME (minutes)
HAWSER FORCES (tons)
VALVE TIME (minutes)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.0
5.0
4.0
3.0
2.0
1.0
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
FILL TIME
HAWSER FORCE

2 December 1999

ORMSS
LOCK MODEL TESTING PROGRAM

1. Phase I. Phase I of the testing program involves construction of a general model facility with a lock foot print which is capable of representing the most critical hydraulic features that would impact lock filling and emptying characteristics for all ORMSS sites. The primary focus of the Phase I testing is to analyze filling and emptying alternatives for the proposed extended auxiliary lock chambers. When compared to the plans currently being recommended for Greenup and JT Myers, it is anticipated that these alternatives would result in cost savings while maintaining safe filling and emptying characteristics. Examples of potential alternatives include:

   (a) a through-the-sill system in combination with flat culverts routed over the existing lateral field to supply either a side-wall port system or a bottom lateral system in the extended portion of the modified lock;
   (b) filling the new lateral field in the extended portion of the lock by extending the existing auxiliary lock culvert (extended culvert will supply the existing lateral field and the new lateral field);
   (c) extending and increasing the size of the existing auxiliary culvert to fill the existing laterals and the new lateral field in the extended portion of the lock;
   (d) investigating various emptying alternatives which may include emptying behind the lower guide wall, emptying into the lower approach, etc.

   For the Phase I testing, a lock foot print that has a 6-lateral filling and emptying system in the existing section of the extended lock will be used and tested under a full range of lift from 15 – 35 feet. However, it should be noted that the data developed for this general model is to be exported to other lock structures currently being studied and proposed for future study during the ORMSS. Therefore, the general model facility must have the capability to vary the culvert size, port size, lateral dimensions and number of laterals. For the Ohio River navigation projects, the range of variability required to model these features are reflected in Attachment 1. In addition, the model facility must be wide enough to incorporate varying site conditions for the Phase II – IV testing.

2. Phase II. Due to the current ORMSS schedules and the minor revisions that would have to be made to the general model, it is recommended that JT Myers be the first project for site-specific model testing. If a more cost effective filling and emptying system is identified during the Phase I testing, it would be adapted to the JT Myers site conditions. However, depending upon the results of the Phase I testing, it is noted that site specific modeling for the Myers project may not be required. If a more cost effective filling and emptying system is not identified during Phase I, the currently proposed filling and emptying system would be model tested.

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ORMSS
LOCK MODEL TESTING PROGRAM
(cont'd)

3. Phase III. Upon completion of the Phase II testing, the model would be revised to reflect site-specific conditions at Greenup and used to perform general testing of an 11-lateral filling and emptying system. If applicable, design information from the Phase I and II testing would be utilized. However, if a more cost effective filling and emptying system is not identified during Phase I, the currently proposed filling and emptying system would be model tested. The model facility must have the capability to vary the lift, culvert size, port size, lateral dimensions and number of laterals.

4. Phase IV. Upon completion of the Phase III testing, the model will be revised to reflect site-specific conditions at a Pittsburgh District Lock site. If applicable, design information from the Phase I, II & III testing would be utilized. The model facility must have the capability to vary the lift, culvert size, port size, lateral dimensions and number of laterals.

5. Summary of Anticipated Model Study Results:

    a. Identification of the most cost effective filling and emptying system that may be adapted for use at future and present ORMSS projects

    b. Documentation of submergence criteria for filling and emptying features inside the lock chamber (relates to safe tow transit in chamber).

    c. Documentation of filling and emptying characteristics (fill and empty times, hawser forces, culvert pressures, loss coefficients, currents & eddies at system intakes/outlets, etc.)

    d. Documentation of impacts (currents, eddies and hawser forces) on tows tied off in the upper and lower approaches

    e. Development of site-specific design data for Greenup and J.T. Myers Lock Extension Projects and then a selected site for Pittsburgh District

6. Note: Phases II through IV may be revised depending upon ongoing ORMSS project studies.

Revised by CELRH-EC-WH, 2 Dec 99, in conjunction with CELRD's Regional Navigation Design Team's Ad Hoc Committee for an Ohio River Filling and Emptying System Model.